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Influence of a Short-Term, Multicomponent Intervention on Balance and Strength Among the Elderly

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Influence of a Short-Term, Multicomponent Intervention on Balance

and Strength Among the Elderly

by

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Abstract

Background: Few studies have combined strength and balance training to assess improvement of activities of daily living among subjects over the age of 65. The purpose of this study was to demonstrate how an eight-week balance and strength training program can lead to improvements in activities of daily living among elderly individuals.

Methods: The subjects consisted of 14 elderly women and 3 elderly men who were all residents of an independent living community. There were 10 subjects in the intervention group and 7 subjects in the control group. The intervention group participated in a supervised balance and strength training program twice a week for eight weeks.

Results: Significant improvements were observed in the intervention group in regard to upper body strength and balance performance.

Conclusions: Balance and strength exercises increase muscular strength and dynamic balance which may, in turn, improve an older individual's ability to perform activities of daily living.

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Chapter 1: Introduction

In 2011, approximately 7,000 people every day in the United States celebrated their 65th birthday. This number is projected to increase dramatically throughout the first half of the 21st century as the baby boomers (those born between 1946-1964) reach this milestone (Vincent & Velkoff, 2010). The number of people age 65 and older is expected to increase 79% by the year 2030, while the population as a whole is anticipated to increase only 20% (U.S. Census Bureau, Population Division, Interim State Population Projections, 2005).

This disproportionate increase among the elderly population demands focus on preventive and proactive interventions as well as more in-depth focus on long-term care (Knickman & Snell, 2002; Burke, Feder & Van de Water 2005). The ramifications of an increasingly older population unable to perform activities of daily living are insurmountable in terms of health care costs and long-term care demands (Centers for Disease Control and Prevention, 2011; Knickman & Snell, 2002; Burke et al., 2005). Total long-term care costs in 2000 were $120 billion, and that number is anticipated to exceed $270 billion in 2030 (Knickman & Snell, 2002). Likewise, the $2.8 trillion spent on healthcare costs in 2011 is expected to increase to $4.3 trillion by 2017, with $54.9 million of that being solely attributed to fall-related injuries (Jacobson, Thompson, Wallace, Brown, & Rial, 2011; Zenker, 2012). For many elderly individuals, the ability to maintain mobility and the ability to perform normal everyday activities is essential to a higher quality of life (Jacobson et al., 2011; Jones and Rikli, 2002; Safdar et al., 2010). This rationale, coupled with the aforementioned statistics, proves a need for exercise programs that are specifically designed for older adults that focus on balance, strength, and functional fitness (Jacobson et al., 2011; Jones and Rikli, 2002; Rose, 2010).

An estimated 90 million Americans are living with a chronic health condition such as diabetes, heart disease, or obesity, and as our population ages, this number is expected to increase substantially (Durstine, Moore, Painter, & Roberts, 2009). Treating chronic diseases is a costly endeavor. In 2005, chronic diseases accounted for more than 75% of the nation's $2 trillion medical care budget, and by 2011 they accounted for 85% of health care costs (Durstine et al., 2009; Zenker, 2012).

About 80% of older adults have at least one chronic health condition, while 50% have at least two (Centers for Disease Control and Prevention, 2011). In addition to the increase in chronic disease, aging adults also incur sarcopenia (loss of muscle mass and strength) and decreased bone mineral density (Durstine et al., 2009; Westcott & Baechle, 1999; Westcott & Simmons, 2006). Aging also negatively affects the sensory, motor, and cognitive systems (Rose, 2002; Rose, 2010; Sturnieks, St. George, & Lord, 2008). The cumulative decline of these physiological factors results in a reduction in environmental perceptions and precision of movement (Alfieri et al. 2010; Rose, 2010; Sturnieks et al., 2008). All of these physical components are integral to balance and function (Rose, 2010; Sturnieks et al., 2008). While certain lifestyle activities may protect against functional limitations, exercise is a necessary element for greater functional capacity (Brach, Simonsick, Kritchevsky, Yaffe, & Newman, 2004; Collins, Rooney, Smalley & Havens, 2004; Sturnieks et al., 2008). Greater function and strength, specifically of the lower extremities, has been shown to have a positive influence on fall reduction among older adults, while deficits in these areas are linked to a heightened fall risk (Kruse, LeMaster & Madsen, 2010; Sturnieks et al., 2008). Positive trends indicate that all of these physiological changes can be mitigated through regular exercise (Sturnieks et al., 2008; Westcott & Baechle, 1999). Unfortunately, only 25% of older Americans are active enough to reap these benefits and alarmingly, 28% of men and 66% of women over the age of 74 are unable to lift more than 10 pounds (Collins et al., 2004; Nied & Franklin, 2002; Rose, 2010). Additionally, the percentage of active older adults continues to decline with age, as only about 15% of individuals over the age of 75 are physically active (Collins et al., 2004).

Unfortunately, a universal aspect of aging is a decrease in muscular strength (Mazzeo et al. 1998; Rose, 2010; Sturnieks et al., 2008; Westcott & Baechle, 1999). However, several studies have indicated that regardless of age, resistance training can have a positive effect on muscular strength and endurance (Chodzko-Zajko et al., 2009; Nied & Franklin, 2002; Westcott & Baechle, 1999; Westcott, Richards, Reinl, & Califano, 2000). The phrase "Use it or Lose It" is very appropriate as it has been supported in the literature that older adults can maintain and even gain muscle mass and strength through resistance training. On the contrary, a sedentary lifestyle only furthers the muscular atrophy associated with aging as it leads to an increased loss of muscular strength and function (Chodzko-Zajko et al.; Haff, 2005; Mazzeo et al.; Nied & Franklin, 2002; Westcott et al., 2000).

A normal characteristic of aging is a decrease in physical activity. If no steps are taken to increase physical activity, then an individual risks becoming chronically sedentary (Chodzko-Zajko et al., 2009; Durstine et al., 2009; Safdar et al., 2010). A chronically sedentary lifestyle encourages self-limiting behavior due to a decrease in muscular strength. This may then lead to a decrease in mobility, frailty, and an increase risk for falls (Chodzko-Zajko et al.; Durstine et al.; Haff, 2005; Safdar et al.).

About one third of older adults fall each year (Centers for Disease Control and Prevention, 2012; DiBrezzo, Shadden, Raybon, & Power, 2005). The most common factors attributing to an increased risk for falls are poor balance, lower extremity weakness, reduced muscular torque, slow reaction time, decreased lean body mass, impaired cognition and vision, syncope, and overall impaired mobility (DiBrezzo et al.; Jacobson et al. 2011; Karinkanta et al., 2007; Sturnieks et al., 2008). One of the main strategies for fall prevention is exercise, specifically those that focus on increasing leg strength and improving balance (Centers for Disease Control and Prevention; Karinkanta et al., Rose, 2010; Sturnieks et al.). Additionally, evidence has revealed how effective exercise is at preventing and even reversing functional limitations and disabilities among sedentary older adults, especially those who are at an increased risk for falling (Buchner, 2003; Chodzko-Zajko et al., 2009; Durstine et al., 2009; Safdar et al., 2010). More in-depth studies have reported that physical activity may preserve muscle mass, improve physiologic impairments such as muscle weakness, and maintain mitochondrial function in older adults (Buchner, 2003; Safdar et al., 2010).

Purpose of the Study

The purpose of this study is to determine the impact of an eight-week strength and balance training program on individuals over the age of 65. Specifically, this study examined a variety of assessments as they relate to specific items from the Senior Fitness Test—the 8-foot up-and-go test, which measures walking agility and speed; chair stand test, which measures lower body strength; and arm curl test, which measures upper body strength (Jones and Rikli, 2001). The study also examined the overall scoring on the Short Form Berg Balance Scale (SFBBS). The SFBBS (a seven-item test), is derived from the Berg Balance Scale, a fourteen-item test that has been widely used with older adults to assess ability to perform a series of functional tasks that require balance. The Berg Balance Scale, named after one of its developers, Katherine Berg, is a widely used clinical test of an individual's static and dynamic balance (Berg, Wood-Dauphinėe, Williams, & Gayton, 1989; Chou et al., 2006).

Significance of the Study

Few studies have combined strength and balance training to assess improvement of activities of daily living among healthy older subjects. Furthermore, the research performed thus far in this area has been so widespread in terms of frequency, type, intensity, and duration that there is a significant need to detail the specifics of a multicomponent exercise program that elicits not only the most beneficial results but that is realistic and suitable to deliver to older adults in a community-based setting. The importance and need of this study is to demonstrate how an eight-week training program can lead to improvements in activities of daily living. In addition, this study will be used to demonstrate how a low-cost, easy to instruct strength and balance training program could be implemented among a group of older adults in a short period of time.

Research Questions

Research Question 1. When compared to the control group, will participants of the intervention group demonstrate significantly improved times in the 8-foot up-and-go test?

Research Question 2. When compared to the control group, will participants of the intervention group demonstrate significant improvement in the arm curl test?

Research Question 3. When compared to the control group, will participants of the intervention group demonstrate significant improvement in the chair stand test?

Research Question 4. When compared to the control group, will participants of the intervention group demonstrate significant improvement on the Short Form Berg Balance Scale?

Delimitations

1. Ten individuals over the age of 65 from the same retirement community who were willing to commit to eight weeks of strength and balance training were the subjects.

2. Seven individuals over the age of 65 from the same retirement community who agreed to be the control group and undergo pre-evaluation testing and post-8 week testing. None of the programmed strength or balance training was performed by control group.

3. The participants completed a strength and balance training program designed for functional fitness that met for one-hour sessions, twice a week for eight weeks.

4. That all training sessions and testing were administered and supervised by a National Academy of Sports Medicine (NASM) certified personal trainer who is also a fitness specialist at the retirement community wherein the subject research took place.

5. That the strength and balance training program was designed by the aforementioned fitness specialist through a modification of the FallProof!™ program.

6. That the testing protocols and methods used are derived from The Senior Fitness Test and the Short Form Berg Balance Scale.

7. That all of the subjects were residents of the same retirement community.

Limitations

1. That all testing, training, and program design was performed by the same person.

2. That the age of the subjects is chronological versus biological age.

3. That the subjects came to the study with varying degrees of absolute strength and functional fitness.

4. That the arm curl test (used to assess upper body strength) is limited to elbow flexion and contraction of the bicep muscle in the subjects' dominant arm.

5. That the sample size is directly related to the fact that the average age of the residents at the sampling site is 87 years old, and finding willing and able participants is difficult for this age demographic.

6. That the selection of the intervention group, due to the characteristics of the sampling site, was non-random and one of unintended convenience as it included only those individuals who were interested and motivated to participate in the intervention. Furthermore, the control group contained individuals who were not interested in the intervention but willing to be part of the control group.

7. That the results of the study will indirectly be affected by motivation and compliance of the participants.

8. That due to unforeseen illnesses and scheduling conflicts, many of the participants missed at least one of the 16 sessions of the program.

Definitions

*ADL (*Activities of Daily Living)- The things a person normally does in daily living including any daily activity they perform for self-care (feeding, bathing, dressing, and grooming), work, homemaking, and leisure. The ability or inability to perform ADLs can be used as a very practical measure of ability or disability.

Bone Mineral Density- The amount of minerals (namely calcium) in a specific area of a bone, which gives an overall picture of bone health.

Clinical Significance- The value or perceived change in physical status post intervention or treatment.

Core Musculature- The muscles of the torso, which provide support for the spine and pelvis.

Elderly- Of, relating to, or characteristic of older persons or life in later years. Individuals 65 years of age and older.

Exercise Prescription- A specific plan of fitness-related activities that are designed for a specified purpose, which is often developed by a fitness or rehabilitation specialist for a client or patient.

Functional Capacity/Fitness- The capability of performing tasks and activities that people find necessary or desirable in their lives. The ability to perform tasks that replicate the movements found in life.

Lean Body Mass- The mass of the body minus its fat stores. This includes muscle as well as bone and other nonfat tissue.

Long-term Care- A variety of services that help meet the daily medical and non-medical need of people with a chronic illness or disability who cannot care for themselves for long periods of time.

Mobility- The ability to move independently and safely from one place to another.

Muscular Endurance- The ability of a muscle or group of muscles to sustain repeated contractions against a resistance for an extended period.

Muscular Power- How quickly and effectively a muscle or group of muscles can move a force.

Muscular Strength- The ability of a muscle or group of muscles to generate force in a single maximal effort.

Myocardial Infarction- The complete obstruction of blood flow through a coronary artery, which results in death of a portion of heart muscle; also known as a heart attack.

Physical Activity Plan- A specific plan for exercise related activities that are designed specifically for an individual. A general outline used for exercise prescription.

Proprioception- The unconscious perception of movement and spatial orientation arising from stimuli within the body itself.

Sarcopenia- The degenerative loss of skeletal muscle mass and strength associated with aging.

Somatosensory- Relating to sensory activity having its origin elsewhere than in the special sense organs (as eyes and ears) and conveying information about the state of the body and its immediate environment.

Syncope- The medical term for fainting, which is defined as a transient, self-limited loss of consciousness with an inability to maintain postural tone that is followed by spontaneous recovery.

Transient Ischemic Attack- A stroke that comes and goes quickly that occurs as a result of a brief interruption in blood flow to the brain.

Type II Muscle Fiber- Muscle fibers that rapidly contract and are primarily used to generate short bursts of strength and speed. Also known as "fast twitch" muscles fibers.

Vestibular Function- The workings of the inner ear that control balance and equilibrium in mammals. It processes sensory information and alerts the body to changes in movement via the central nervous system.

Chapter 2: Review of Literature

What does it mean to age? According to the American Heritage Medical Dictionary, aging is defined as “1. The process of growing old or maturing. 2. The gradual changes in the structure of a mature organism that occurs normally over time and increases the probability of death” (2010). The Encyclopedia Britanncia (2012) further defines aging as “progressive physiological changes in an organism that lead to senescence, or a decline of biological functions and of the organism’s ability to adapt to metabolic stress.”

Aging is inevitable, and the population in the United States is increasingly becoming older. As evident from Appendix A, the first half of the 21st century will see a significant increase in the number of Americans over the age of 65 (Vincent & Velkoff, 2010). Specifically, in 2050 this number is expected to increase to 88.5 million, more than double the population of Americans over the age of 65 in 2010 (Vincent & Velkoff, 2010). Physical degradation is a natural aspect of aging that affects almost every system of the body. In terms of motor function, aging reduces muscle mass, bone density, and flexibility and manifests changes in the central nervous system, all of which affect an older individual’s movement and increases his or her risk of falling due to greater instability (Kammerlind, Hakansson, & Skogsberg, 2001; Kruse et al., 2010; Mazzeo et al. 1998; Rose, 2010). Almost twenty-five percent of older people who fall will sustain a moderate to severe injury, including hip fractures and head injuries (Centers for Disease Control and Prevention, 2012). These injuries can deprive older adults of their independence and increase their risk of early death. In fact, falls are the most common cause of traumatic brain injuries and among older adults account for a significant number of fatalities (Centers for Disease Control and Prevention, 2012). Even if an older adult is not significantly injured from a fall, it still has a negative effect as it causes a fear of falling, which in turn causes them to limit their activities and leads to an increased sedentary lifestyle. An increased sedentary lifestyle segues to reduced mobility and function and frailty (Durstine et al., 2009; Jacobson, Thompson, Wallace, Brown, & Rial, 2011; Safdar et al., 2010). Frailty, although a common term, is medically diagnosed as the condition of someone who has muscle weakness, low physical activity, slow walking speed, physical exhaustion, and unintentional weight loss (Durstine et al.; Graf, 2006). This downward spiral of self-limiting behavior and the potential for frail health increases an older adult's risk of subsequent falls (Centers for Disease Control and Prevention, 2012; Durstine et al.).

To help mitigate the costly and debilitating effects of aging, specifically chronic disease and falls, the American College of Sports Medicine (ACSM) in conjunction with the American Heart Association (AHA) currently recommends the following exercise guidelines for individuals 65 and over (Nelson, 2007):

> Do moderately intense aerobic exercise 30 minutes a day, five days a week *or* Do vigorously intense aerobic exercise 20 minutes a day, 3 days a week *and* Do eight to 10 strength-training exercises, 10-15 repetitions of each exercise twice to three times per week *and* If you are at risk of falling, perform balance exercises *and* Have a physical activity plan. (p. 1437)

The total time required per week to meet the aerobic exercise portion of these recommendations is one to two and a half hours, and the total time to incorporate just the strength training portion of these guidelines is even less of a time commitment: 40 to 60 minutes (Nelson, 2007; Pollock et al., 1998). According to the National Health Interview Survey (Centers for Disease Control and Prevention, 2008), only 16% of men over the age of 75 and 11% of women over the age of 75 are participating in “leisure-time” strengthening exercises (Appendix B).

Muscular Strength

Muscular strength is defined as the maximal amount of force a single muscle or muscle group can produce, while muscular endurance is defined as the ability of a single muscle or muscle group to maintain a repeated muscular contraction over a specific period of time (Chodzko-Zajko et al., 2009; Dwyer, Davis, Pire, & Thompson, 2008). Between the ages of 50 and 70, individuals have approximately a 30% reduction in muscular strength and mass, with the most dramatic changes occurring after the age of 70 (Haff, 2005; Mazzeo et al., 1998). In the 6^{th} and 7^{th} decade, strength declines 15% per decade, with a 30% decline observed in the decades following and these changes in muscular strength adversely affect mobility (Chodzko-Zajko et al.; Mazzeo et al.).

Muscle atrophy, due to the gradual loss of muscle fibers (mainly Type II fibers, which drop from 60% in sedentary young men to below 30% in men after the age of 80), affects muscular strength and power, which can begin to cause balance problems in individuals as young as 50 years of age (Alfieri et al., 2010; Chodzko-Zajko et al, 2009; Haff, 2005; Mazzeo et al., 1998; Sturnieks et al., 2008). Moreover, decreases in muscle power occur at a greater rate than decreases in muscle strength. Additionally, studies have suggested that muscular power-producing capabilities have a stronger association with functional capacity than muscular strength, which is most likely related to the decrease in Type II muscle fibers (Chodzko-Zajko et al.; Durstine et al., 2009; Mazzeo et al.; Sturnieks et al., 2008). Functional capacity is the ability to perform activities of daily living such as getting out of bed, using the toilet, preparing meals, and ambulating without assistance. Muscle weakness, however, can limit functional capacity (Azegami et al., 2007; Chodzko-Zajk, et al.; Durstine et al.; Graf, 2006; Haff).

Because age negatively affects vision, somatosensory input and vestibular function and reduces muscle and nerve fibers, a simple task such as rising from a chair (which requires muscular strength and dynamic balance and is crucial for maintaining independence) may become limited (Alfieri et al., 2010; Graf, 2006; Rose, 2010; Sturnieks et al., 2008). The most powerful predictor of functional capacity among "very old" individuals (defined as those 85 years old and older) is leg power (Mazzeo et al., 1998). Leg power (which declines at 3.5% per year) and strength are highly correlated with risk of falling and gait, accounting for 86% of the variance in gait speed (Mazzeo et al.; Sturnieks et al.). Hence, the ability to walk can be linked to muscular strength and power.

Strength training exercises have been found to improve motor balance issues that are associated with increasing age, reduced muscle strength, impaired cognition, and sensory or motor deficits (Chodzko-Zajko et al., 2009; Durstine et al., 2009; Jones, King, Mist, Bennett, & Horak, 2011). Strength training can increase motor unit activation and muscle fiber size, which increases not only strength but reaction time (the elapsed time between the introduction of a sensory stimulus and the physical response) and balance (Chodzko-Zajko et al.; Jones et al.; Mazzeo et al., 1998; Rogers, Rogers, & Takeshima, 2005).

Balance

Multiple systems within the body contribute to balance (Kammerlind et al., 2001; Rogers et al., 2005; Rose, 2010; Sturnieks et al., 2008). Even though muscular strength and endurance are needed for balance, an individual's ability to control his or her center of mass is a combined effort of various sensory systems (visual, vestibular, and somatosensory) and its control on muscle via sensory motor pathways (Rogers et al.; Rose; Sturnieks et al.). Regardless of the movement or action, multiple systems within the body are required for movement, and no individual system alone can determine body position (Rogers et al.; Rose). Furthermore, the ability to respond to sensory changes and determine movement is dependent on the amount and quality of information received from sensory receptors (eyes, feet, and inner ear) and how that information is relayed once it has reached the central nervous system (Rose; Sturnieks et al.). Aging progressively impairs all of these systems, and cumulative changes in these systems can greatly interfere with a person's ability to perform tasks that require coordination, speed, strength, and balance— namely their ability to perform activities of daily living (ADL; Rogers et al.; Rose; Sturnieks et al.).

Presently, the American College of Sports Medicine's (ACSM) guidelines for exercise for individuals 65 years of age and older do not contain specific training parameters for balance, though they do recommend that individuals within this demographic perform balance exercises if they are at "risk of falling," which is defined as someone who has had frequent falls (more than two falls in a sixth-month period) or mobility problems (Nelson, 2007). The ACSM position on Exercise and Physical Activity for Older Adults (Chodzko-Zajko et al., 2009) further states:

> ACSM/AHA guidelines currently recommend balance exercise for individuals who are frequent fallers or for individuals with mobility problems. Because of a lack of adequate research evidence, there are currently no specific recommendations regarding specific frequency, intensity, or type of balance exercises for older adults. However, the ACSM Exercise Prescription Guidelines recommend using activities that include the following: 1) progressively difficult postures that gradually reduce the base of support (e.g.,

two-legged stand, semitandem stand, tandem stand, one-legged stand), 2) dynamic movements that perturb the center of gravity (e.g., tandem walk, circle turns), 3) stressing postural muscle groups (e.g., heel stands, toe stands), or 4) reducing sensory input (e.g., standing with eyes closed). (p. 1511)

Although several studies have evaluated some form of balance training, their approaches have been broad-based and lack standardized methodology. However, studies utilizing strength and multisensory or multicomponent training observed the most positive results (Alfieri et al., 2010; Jacobson et al., 2011; Mazzeo et al., 1998; Taguchi, Higaki, Inoue, Kimura, & Tanaka, 2010). Recent functional mobility and balance training research has concluded that greater success is observed with mobility and/or balance training programs that contain exercises that not only strengthen the main postural control muscles but also challenge the visual, vestibular, and somatosensory sensory systems (Alfieri et al.; Kravitz, 2010; Rose, 2002).

More than 30% of individuals over the age of 65 will experience at least one fall per year; over half of those individuals will have more than one fall, and 25% percent will be in a nursing home in less than a year (Centers for Disease Control and Prevention, 2012; Costello, 2008; Jacobson et al., 2011; Rose, 2010; Shumway-Cook et al., 2007). Older adults who remain physically active and maintain good postural muscle strength are at a decreased risk for falling, whereas sedentary persons place themselves at a greater risk for falling due to their deconditioned state, lack of mobility, and sensory-motor ability (Alfieri et al., 2010; Rogers, 2005; Rose).

One third to one half of falls among older adults who live in a community setting (e.g., a residential home) are related to extrinsic or environmental factors, such as tripping hazards in the home or performing tasks at night like taking out the garbage, whereas the primary reason for falls among older individuals in a long-term care setting are related to intrinsic factors such as general weakness and cognitive impairment (Rose, 2010). The Centers for Disease Control and Prevention (CDC) indicate that “falls” are the major cause of injury-related deaths among people over the age of 65, mainly due to traumatic brain injuries (Costello, 2008). Additionally, 30% of individuals suffering an injury from a fall will incur an impairment in their ability to perform ADL (Jacobson et al., 2011).

Benefits of Strength Training

Upon review of the literature, we see that it’s clear that strength training has been proven to be beneficial and safe for older adults (Chodzko-Zajko et al., 2009; Mazzeo et al., 1998; Westcott et al., 2000). Unfortunately, there is not enough recent research involving improvement of activities of daily living (ability to rise from a seated position, carry groceries, or perform household chores) for the current healthy senior population solely related to a short-term strength and balance training intervention. However, Westcott et al. (2000) designed a 14-week strength training program for non-ambulatory nursing home patients, which produced both upper and lower body strength improvements and was shown to improve mobility and frequency of falls. Specifically, the strength gains were 38.8% (upper body) and 81.2% (lower body; Westcott et al.). Similar results were obtained in Westcott’s later study wherein a strength training intervention produced significant upper and lower body strength gains (Westcott & Simmons, 2006). This study supports the fact that exercise programs tailored towards improving functional fitness need to include strength training; however, further studies need to be performed to really explore and connect the improvement among independence and the health care cost savings ratio (Westcott & Simons). Complete functional fitness, or the ability to perform activities of daily living and take care of personal needs with no assistance, eliminates the need for any nursing care or home assistance. However, even if an individual is not able to become completely independent, being able to decrease the amount of assistance they require (by virtue of greater strength) has the potential for health care cost savings (Westcott & Simons).

The fascinating and encouraging aspect of Westcott's first study is that the subjects who participated in the study were predominantly non-ambulatory individuals who initially needed a considerable amount of assistance getting on and off the Nautilus machines; however, following the program, all but one participant (a double amputee) reduced their wheelchair dependence (Westcott et al., 2000). The overall physiological improvements observed in Westcott's first study (an 81.2% increase in lower body strength, a 38.8% increase in upper body strength, and a 52.8% increase in hip flexion) are of great significance, but the most relevant gain observed was the improved functional capacity and independence of the participants (Westcott et al., 2000).

Current research continues to reveal how strength training can improve the functional fitness of elderly adults and improve their ability to perform activities of daily living, which ultimately increases and maintains their independence (Blankevoort et al., 2010; DiBrezzo et al., 2005; Kimura et al., 2010). It has been determined that short-term strength training (12 weeks or less) may produce positive functional benefits (such as improving the ability to prepare meals or attend social activities outside of the home) in some subsets of older people, but that the greatest gains in gait speed, functional mobility, and balance are seen utilizing a multi-component intervention (a combination of endurance, strength, flexibility and/or balance) compared to progressive strength training alone (Blankevoort et al.; Kimura et al.).

Multicomponent Training

Blankevoort et al. (2010) performed a detailed literature review on the effects of physical activity on strength, balance, mobility, and ADL performance among elderly subjects with dementia. As cognitive function declines with age, it is imperative to explore how various interventions affect basic activities of daily living among individuals with dementia in order to formulate program recommendations and/or modifications for this subset of the elderly population (Blankevoort et al.; Mazzeo et al. 1998).

In Japan, a country with a rapidly growing older population and a public long-term care program, a 12-month multicomponent intervention was performed with very elderly, lower functioning adults with some minor disabilities (Taguchi et al., 2010). Similar to cognitive decline, some form of physical disability or limitation is inevitable with age (Chodzko-Zajko et al., 2009; Graf, 2006; Mazzeo et al., 1998; Rose, 2010). The purpose of the Taguchi et al. intervention was to research methods in which to shift their long-term care program to a more preventive type program due to the financial overburdening of their current system. Over a period of one year, the intervention group participated in a once-a-week multicomponent supervised exercise class that involved flexibility, aerobic, strength, and balance training (Taguchi et al.). Following this 12-month study, no significant changes were noted among the intervention groups' walking speed or stride length. Remarkably, this is considered significant because the control group (who participated in no exercise intervention) had a significant decrease in walking speed and stride length, which suggests that an exercise program can slow the effects and deterioration of sensory and motor function associated with age (Taguchi et al.).

Conversely, a similar study utilizing "multisensory training" did observe significant improvements in gait speed and agility (Alfieri et al., 2010). The purpose of the Alfieri et al., study was to evaluate the differences and efficacy of a multisensory training program (one involving resistance training and exercises designed to stimulate the three sensory systems—visual, vestibular, and somatosensory) versus a strength training only program. The multisensory training program consisted of stretching, short walks at various speeds and angles (with eyes open and closed), specific resistance training exercises for the feet, squats, abdominal exercises, and balance exercises (e.g. stepping on and walking across mattresses and different densities of rubber foam). The strength training group performed six seated resistance training exercises (that were different from the resistance exercises the multisensory group performed), which targeted all the major muscle groups (Alfieri et al.). In just three months, significant results were observed among the multisensory groups' timed up-and-go (TUG) test and Guralnik test battery (a test that includes three items: static balance, ability to stand from a chair, and walking speed), which was not present in the strength training group. Not to say that no benefits came from the strength training group, because that group did see an improvement in the TUG of 3%; however, the multisensory group demonstrated a significantly larger improvement (11.85%; Alfieri et al.). Interestingly, while the training programs of Taguchi et al. (2010) and Alfieri et al. appear to be somewhat similar in design, they explore two different subsets and of the elderly. In Taguchi et al. the average age was 85 years old, whereas the average age in the Alfieri, et al. was 68.8 years old. Furthermore, the assessment used for walking speed was a 6-minute walk test in Taguchi et al. versus a 10- foot-up-and-go walking test that was used in Alfieri et al. These differences may explain the variance in the results of these two studies.

In yet another study closely paralleling these (Jacobson et al., 2011), subjects performed standing balance exercises and leg strengthening exercises for 12 minutes, 3 times a week, for 12 weeks. The results were consistent with Taguchi et al. (2010) in that the control group saw a decline in function and consistent with Alfieri et al. (2010) in that the intervention group improved significantly in all dependent variables. A main factor of the Jacobson et al. study was that the balance and leg strengthening exercises were all performed standing versus seated.

Remarkably, these exercises were performed without the need of a spotter because all exercises were conducted inside a specially designed aluminum frame with the subject donning a vest that was tethered at the shoulders to the top of each corner of the frame (Jacobson, et al.).

DiBrezzo et al. (2005), using a 10-week intervention that included balance, strength, and flexibility exercises, observed significant improvements in the 8-foot up-and-go, chair stand, and arm curl tests, with the 8-ft up-and-go having the greatest improvement (t =4.60, $p < .001$). A considerable and interesting difference between this study and others that incorporated balance and strength is that the same exercises were not used for two consecutive sessions (DiBrezzo et al., 2005).

There are a variety of fall prevention programs developed thus far targeting elderly adults; however, these programs vary significantly in their design and approach (Costello, 2008; Jacobson et al., 2011; Rose, 2002; Rose, 2008). A critical analysis of fall prevention approaches reveal that exercise alone can decrease an individual's risk for falling, but that it should involve a comprehensive program that includes multiple forms of exercise (strength, balance, flexibility and endurance training) that focus not only muscular strength but also postural control (Alfieri et al. 2010; Costello; DiBrezzo et al., 2005; Jacobson et al.; & Rose, 2010). From the literature, the optimal frequency of such programs appears to be 2 to 3 times per week (averaging 1 ½ - 3 hours per week), for 8-12 weeks (Blankevoort et al., 2010; Costell; DiBrezzo et al.; Jacobson et al.).

Multicomponent or multisensory training programs appear to be the trend observed throughout the above research and one which is producing significant results in terms of balance and functional fitness. It is theorized that physical activity is beneficial to individuals in all stages and conditions of the aging process, including those with disability and dementia (Blankevoort et al., 2010; Taguchi et al., 2010; Westcott et al, 2000; Westcott & Simmons, 2006). The greatest improvements in function (a 9-19% increase in walking speed and agility and a 21-34% improvement in lower limb strength) were observed with multicomponent interventions, or those programs that combined strength, flexibility, balance, and aerobic endurance (Alfieri et al. 2010; DiBrezzo et al., 2005; Taguchi et al.). Additionally, programs that combined strength training and balance produced greater results in walking speed and dynamic balance than strength training or balance training alone (Karinkanta et al., 2007).

Functional Fitness & Mental Component

Using the SF-36 Health Status Survey (a survey designed to assess health-related quality of life [HRQOL] based on physical and mental measures), participants in Kimura et al. (2010) were assessed before and after a strength training intervention. Though the intervention in this study was solely exercise-based, only the mental health portion of the SF-36 revealed significant improvements. Interestingly, no conclusive evidence was provided as to why or how strength training improved the survey results pertaining to HRQOL (Kimura et al.). However, it was hypothesized that the social aspect of going to an exercise class adds to the positive influences in a person's life (Kimura et al.). Another explanation is that the sheer act of performing strength training gives the participant a sense of accomplishment and capability that they may not be getting in other areas of their life (Kimura et al.). While Kimura et al. revealed only significant findings relating to mental health, other studies that have been based on physical assessments (rather than subjective surveying) have revealed significant results in functional fitness (Blankevoort et al., 2010; Jacobson et al., 2011).

Although a multicomponent program appears to be the most effective at improving functionality in older adults, the specifics of such a program are unclear and more research is needed. Specifically, there is a need to determine the most effective and practical training design relating to a multisensory or multicomponent exercise program for older adults (Kuptniratsaikul et al., 2011; Rose, 2008; Shimada, Uchiyama, & Kakurai, 2002).

Chapter 3: Methodology

Subjects

Subjects for this study were recruited by verbal solicitation and announcements made by the author of this study, who is an fitness specialist at the Village of Westland, an independent senior living community operated by Presbyterian Villages of Michigan located in Westland, Michigan. The intervention group included ten subjects (8 women and 2 men) ranging in age from 82-92 years of age (mean age 87.2 $\pm$ 3.39 years). The control group included seven subjects (6 women and 1 man) ranging in age from 76-91 years of age (mean age 86.7 $\pm$ 5.28 years). Residents were eligible for the aforementioned program if they:

- Were able walk 20 feet without assistance (assistive device or person)
- Were able to rise out of a chair independently (use of chair arms allowed)
- Were able to stand for two minutes consecutively
- Were available to participate in an 8-week program

The Village of Westland is a senior living community located within a middle-class socioeconomic demographic. This was a non-randomized sampling. The subjects were not randomly placed into the intervention or control group. The subjects who were willing and able (and thus more motivated) composed the intervention group. A small, non-randomized sample size is an obvious limitation of this study, but the reality is that finding subjects in this age demographic to participate in this type of intervention is difficult. The control group contained individuals who were active in the community, but not interested, available, and/or motivated to participate in an 8-week intervention. However, in defense of the potential bias this may create, it should be noted that baseline physical assessments and anthropometric characteristics of the intervention and control group did not differ significantly ($p > .05$). As the recruiting process was done verbally by the aforementioned fitness specialist, only residents who participated in fitness classes or were active within the community would have heard about or been approached about participation in the study.

All subjects who were part of the intervention group had to fill out a health history questionnaire and obtain medical clearance from their physician prior to participating in the program (Appendix C & D). Due to the fact that the intervention was designed to serve a small group, a maximum of four subjects at a time went through the intervention. The first four subjects to return their paperwork were selected as the first group, and the remaining subjects were assigned to subsequent groups based on the order in which their completed paperwork was received.

Pre-intervention Assessments

Both the intervention group and the control group underwent the same pre-assessment testing. The mean height of the subjects within the intervention group was 161.3 $\pm$ 5.92 cm, and the mean height of the control group was 162.6 $\pm$ 9.96 cm. The mean weight of the intervention group was 61.7 $\pm$ 10.68 kg, and the mean weight of the control group was 61.9 $\pm$ 10.99 kg. The assessment process consisted of highly reliable and valid testing protocols taken from the Senior Fitness Test and the Short Form of the Berg Balance Scale (SFBBS). Reliability and validity for the Senior Fitness Test are estimated at .80, and ≥.70, respectively, while reliability and validity for the SFBBS are estimated at .80 and ≥.96, respectively (Chou et al., 2006; DiBrezzo et al., 2005; Jones & Rikli, 2002). For this study, three of the six Senior Fitness Test items were selected to be used in this study, along with the SFBBS, which was derived from the Berg Balance Scale. The specific items used from the Senior Fitness Test were:

- 8-foot up-and-go test

- Arm curl test
- Chair stand test

These tests measure walking agility and speed, lower body strength, and upper body strength, respectively. The three remaining Senior Fitness Test items that were not included involved upper and lower body flexibility and aerobic endurance. The Short Form of the Berg Balance Scale, consisting of seven items, is derived from the Berg Balance Scale, a fourteen-item test that has been widely used with older adults to assess ability to perform a series of functional tasks that require balance (Chou et al., 2006). The SFBBS was selected over the original Berg Balance Scale test because it takes less time to administer (which is important when dealing with an elderly population due to fatigue and the influence thereof in testing) and has been proven to assess the main components of balance without redundancy and less inconsistency with scoring (Chou et al.). The combination of these two tests was selected because they are not only easy to administer but also can be used across a broad continuum of functioning among older adults (Chou et al.; Jones & Rikli, 2002). These test items all have significance as they relate to an individual's ability to perform activities of daily living (ADL) and risk for falling (Chou et al.; Jones & Rikli; Rose, 2010).

Administration of Assessment

All residents who participated in the study wore individual emergency call buttons, which is a safety requirement for all residents regardless of activity. As stated previously, each 8-week training group was kept to a maximum of four participants so that the instructor could spot the participants and provide balance support for certain exercises.

Intervention

The primary investigator of this study who conducted the training is a National Academy of Sports Medicine (NASM) certified personal trainer. She is currently employed as a fitness specialist whose main job duties are that of developing and instructing fitness classes and wellness programming for older adults. The intervention group participated in an 8-week strength and balance training program that consisted of 2 one-hour training sessions each week. The balance training portion of the intervention was created by a modification of Dr. Debra Rose's "FallProof!" program and incorporated exercises that challenged the visual, vestibular, and somatosensory systems. So as muscular fatigue did not hinder precision of movement, balance exercises were performed for the first thirty minutes of the class, and strength exercises were performed during the that last thirty minutes of the class.

At the beginning of each session, subjects performed warm-up exercises that consisted of holding tall posture and easy stretching. Tall posture is executed by sitting upright and retracting and depressing the scapula all while tightening the core musculature and focusing on a vertical target. The main seated balance set began with marching and followed a progressive sequence detailed in Appendix E. Seated balance included an altered base of support (e.g. sitting on a Dyna Disc or stability ball) and cued visual variances (e.g. eyes closed or performing visual tracking exercises). The standing balance portion of the class included exercises with an altered base of support (e.g. standing on one leg or standing on a mat); gait pattern and obstacle training (e.g. walking a zigzag pattern through cones, walking stops and starts, tip toe walking and heel walking); and tandem standing and one-legged exercises. During the first week, the exercises started out rather simple, such as holding tall posture while seated and one-legged standing drills, but gradually became more difficult by incorporating altered bases of support as the participants progressed in their balance ability. As the subjects became perfectly stable in one situation, the exercises were progressed in order to increasingly challenge the subjects' proprioception. For example, seated balance exercises progressed from sitting (and holding tall posture) in an armless chair, to sitting in an armless chair with a Dyna Disc on the seat, to sitting in an armless chair with a Dyna Disc on the seat while the feet were on another Dyna Disc placed on the floor in front of them (Figure 1). This then progressed to sitting on a stability ball placed in a ball holder. In all of these scenarios, the subjects held tall posture all while performing various arm or leg movements, visual tracking, and weight shifts (Figure 1). The participants also performed one exercise from the strength portion of this intervention (the bicep curl) while sitting on an altered base of support and later moved to a standing bicep curl (Figure 1).

a. b. c.

Fig. 1. Illustrations of seated balance exercises.

a) seated balance with marching using two Dyna Discs, b) seated balance on stability ball while performing bicep curl, c) seated balance on stability ball with visual tracking.

The strength training portion of this intervention included four exercises on Keiser pnuematic resistance machines: chest press, leg press, leg curl, and upper back. These weight machines were chosen as the primary mode for strength training because not only are they located in the fitness center where this study took place, but they are also more effective and safe in building strength as the pneumatic mechanical system provides consistent resistance during both the concentric and eccentric phases of muscle contraction (Figure 2).

Fig. 2. Images of Keiser pneumatic resistance machines. a) Air250 Upper Back, b) Air350 Biaxial Chest Press, c) Air250 Leg Curl and d) Air250 Leg Press; Keiser, Freso, CA

The only disadvantage in using this equipment is the fact that getting on and off the equipment can be a cumbersome challenge for some older adults, especially those with mobility and flexibilty issues. To ensure safety and proper execution of the exercises, physical assistance was used to get some of the subjects positioned properly on the equipment. The remaining exercises were a seated/standing dumbbell bicep curl, wall squats, and a cable upright row (performed on the Technogym Radiant). The bicep curl was chosen because it was part of the initial assessment and because the bicep muscle is active when lifting a bag of groceries or carrying a laundry basket. The wall squats were chosen to further increase the strength of the lower body and because it is an exercise subjects could easily continue on their own following the intervention. The upright row was chosen because it not only introduced the subjects to the cable system (yet another mode to use for strength training), but because it is a good exercicse to isolate the shoulder muscles, while also working the trapezius muscle. Due to the nature of this exercise, proper form was closely monitored and corrected, and excessive internal rotation of the shoulder was avoided so as to eliminate any potential shoulder issues arising from this exercise. As part of the assesssment process, settings and suitable weight/resistance was selected for each participant based on percieved exertion and was a weight they were successfully able to lift for 12 repititions. During the training, the participants were asked for feedback regarding their perceived exertion (which was assessed via verbal communication) and questioned often regarding their tolerance of each exercise. The subjects performed two sets of 12 repetitions for each of the seven strength training exercises. When 12 repetitions were completed with proper form and were becoming “easy,” then the weight/resistance was increased 5-10%, according to the participant’s rate of perceived exertion.

Statistical Analyses

Following the 8-week training period, each individual from the intervention group was evaluated using the same pre-intervention assessments. Because this study compared each individual subject to his or her own performance and the differences in physical ability between males and females in this age demographic are not significant, gender was not used as a covariant. The individuals from the control group (who underwent no training) were also reassessd following an 8-week period. Data analysis was conducted using Predictive Analytics SoftWare (PASW) Statistics 18 for Windows, Release Version 18.0.0 (SPSS, Inc., 2009, Chicago, IL), and statistical significance was set at $p < .05$. Calculation for central tendency measures were completed via one sample *t* tests to identify the nature of the distribution for both groups relating to anthropometic measurements and pre-intervention physical function. Descriptive statistics, including means and standard deviations, were calculated for all dependent variables. The effects of the 8-week strength and balance intervention on the 8-foot up-and-go, chair stand, arm curl, and SFBBS were determined by paired sample *t* tests for dependent samples.

Chapter 4: Results

The results of this study are an analysis of individual pre-intervention and post intervention results to determine if the intervention had any significant effect. The mean age of the subjects within the intervention group (N=10) was 87.2 $\pm$ 3.39 years and the mean age of the subjects within the control group (N=7) was 86.7 $\pm$ 5.28 years. The mean weight and height of the intervention group was 61.7 $\pm$ 10.68 kg/161.3 $\pm$ 5.92 cm, and the mean weight and height of the control group was 61.9 $\pm$ 10.99 kg/162.6 $\pm$ 9.96 cm. The intervention group included 8 women and 2 men and the control group included 6 women and 1 man. Statistical analysis revealed no significant differences ($p > .05$) among age or anthropometric characteristics between the intervention and control group.

There were 16 training sessions in total and the mean attendance rate was 88.4%. Effects of the training intervention were evaluated via paired dependent sample *t* tests that revealed no significant changes (pre-intervention to post intervention) among the control group relating to the arm curl test, chair stand test, 8-foot-up-and-go, and the SFBBS. Paired dependent sample *t* tests did, however, reveal significant effects following the 8-week training period among the intervention group with regard to the arm curl test ($t = -5.51$, $p < .001$) and the SFBBS ($t = -9.0$, $p < .001$). Non-significant improvements were observed in the chair stand test and 8-foot up-and-go test. However, clinical significance in both of these dependent variables was present. Clinical significance is the practical or applied value or change in physical status post treatment (Houle & Stump, 2008). Specifically, there was a positive trend in the performance of the two aforementioned dependent variables, which in this type of study is more important than statistical significance. Table 1 shows the results from all pre-and post assessments for both the intervention group and the control group and Tables 2 and 3 display individual results from both the intervention and control groups.

Table 1

Results of Pre- and Post-Testing: Intervention & Control Group

Intervention (N=10)				
	Pre	Post	*t* score	P-value
8-ft up-&-go (seconds)	10.69± 4.15	9.51± 3.46	2.182	.057
Arm Curl (repetitions)	9.50 ± 4.0	12.40 ± 3.6	-5.51*	.000*
Chair Stand (repetitions)	9.0 ± 6.13	10 ± 6.33	-1.54	.158
SFBBS (points)	21.8 ± 1.4	24.2 ± 1.03	-9.0*	.000*

Control (N=7)				
	Pre	Post	*t* score	P-value
8-ft up-&-go (seconds)	12.54± 5.24	12.73± 6.0	-.35	.735
Arm Curl (repetitions)	9.29±2.14	8.86±2.41	.66	.534
Chair Stand (repetitions)	5.14 ± 4.6	4.14 ± 4.34	2.05	.86
SFBBS (points)	20.14 ± 5.84	19.29± 5.31	.89	.407

Note. SFBBS = Short Form Berg Balance Scale.
*$p < .001$.

Table 2

Individual Results of Pre- and Post-Testing: Intervention Group

Gender	Age	Ht./Wt. (cm/kg)		8 ft. up & go (seconds)	Arm Curl (reps)	Chair Stand (reps)	SFBBS (points)
Female	92	163.8/70.9	Pre-	17.4 sec.	5	0	22
			Post	13.2 sec.	8	0	24
			% of change	24%	60%	0%	9%
Female	87	154.9/52.27	Pre-	8.6 sec.	6	13	22
			Post	8.2 sec.	11	13	24
			% of change	5%	83%	0%	9%
Female	83	160/50	Pre	11.9 sec.	11	19	22
			Post	12.6 sec.	17	20	24
			% of change	-6%	55%	5%	9%
Female	90	157.5/53.64	Pre-	8.6 sec.	9	13	21
			Post	9.2 sec.	12	15	24
			% of change	-7%	33%	15%	14%
Female	86	160/52.27	Pre-	12.1 sec.	9	6	21
			Post	10.5 sec.	12	8	24
			% of change	13%	33%	33%	14%
Female	84	161.3/70.45	Pre-	4.7 sec.	19	14	24
			Post	4.2 sec.	19	12	25
			% of change	11%	0%	-14%	4%
Female	90	152.4/50.91	Pre-	5.9 sec.	12	10	24
			Post	5.8 sec.	15	9	26
			% of change	2%	25%	-10%	8%
Female	82	167.6/68.18	Pre-	16.8 sec.	7	0	20
			Post	15.4 sec.	9	0	22
			% of change	8%	29%	0%	10%
Male	88	172.7/77.3	Pre-	11.4 sec.	7	6	22
			Post	7.4 sec.	9	9	25
			% of change	35%	29%	50%	14%
Male	90	162.6/70.9	Pre-	9.5 sec.	10	9	20
			Post	8.6 sec.	12	14	24
			% of change	9%	20%	56%	20%

Note. SFBBS = Short Form Berg Balance Scale.

Table 3

Individual Results of Pre- and Post-Testing: Control Group

Gender	Age	Ht./Wt. (cm/kg)		8 ft.up & go (seconds)	Arm Curl (reps)	Chair Stand (reps)	SFBBS (points)
Female	91	165.1/70.9	Pre-	15.8 sec.	6	0	22
			Post	17.4 sec.	5	0	22
			% of change	-9.9%	-33%	0%	0%
Female	85	170.2/72.73	Pre-	8.7 sec.	11	8	20
			Post	7.7 sec.	10	9	18
			% of change	8.7%	-9%	13%	-10%
Female	76	167.6/70.45	Pre-	9.6 sec.	12	2	26
			Post	11.4 sec.	11	0	20
			% of change	-19%	-8%	-100%	-23%
Female	91	147.3/47.73	Pre-	10.6 sec.	10	6	22
			Post	10.9 sec.	8	4	22
			% of change	-3%	-20%	-33%	0%
Female	86	160/52.27	Pre-	12.1 sec.	7	8	19
			Post	12.1 sec.	9	6	21
			% of change	0%	29%	-25%	11%
Female	90	152.4/50.91	Pre-	8.1 sec.	10	12	24
			Post	6 sec.	12	10	24
			% of change	26%	20%	-17%	0%
Male	88	175.3/68.18	Pre-	22.9 sec.	9	0	8
			Post	23.6 sec.	7	0	8
			% of change	-3%	-22%	0%	0%

Note. SFBBS = Short Form Berg Balance Scale.

Chapter 5: Discussion

The purpose of this study was to investigate the effects of a short-term, multicomponent intervention on balance and strength among elderly individuals. The American elderly population is in the midst of rapid growth. The population over the age of 65 is estimated to more than double between 2010 and 2050, growing from 40.2 million to 88.5 million (Vincent & Velkoff, 2010). Due to the anticipated rise in the number of older adults in the next 40 years, it is imperative that exercise is encouraged for this population and that programs are designed to focus on improving functional capacity and reducing the risk of falls. If older adults are able to maintain independence and mobility, then they will be able to retain their quality of life and potentially lessen the burden on health care and long term care costs.

Improving independence and functional capacity represents the potential for noteworthy savings in health care costs (Westcott et al., 2000). By 2050, as a result of the ever increasing older population, health care costs are estimated to increase by 25% unless the health of our older population can be maintained or improved, which includes fall related injuries (Rose, 2008). The annual health care costs attributed to fall-related injuries are $37 billion (Jacobson et al., 2011). Implementing programs that can reduce falls may have tremendous economic potential as reducing fall-related injuries by merely 2% could reduce health care costs by $74 million a year (Jacoboson et al.).

Long term care costs, which are separate from health care costs, are expected to continue to rise significantly. In 1980, $9 billion was spent on long-term care and this amount rose to $54 billion in 2010. With long-term care expenditures estimated to increase 2.6% annually over the amount of inflation, this equates to $270 billion in long-term care costs by 2030 (Knickman & Snell, 2002). In order to maintain more independent members of our society, funding should focus on preventive measures that assist in maintaining function for older adults. This has a two-fold benefit, not only does is have the potential to avoid or limit long-term care costs, but also represents a economical gain for our society by keeping older adults able bodied members of society (Knickman & Snell).

The main finding of this study was that the intervention group had significant improvements in the arm curl test (measure of upper body strength) and on the Short Form Berg Balance Scale, which were not evident among the control group. The main limitation of this study was the small non-randomized sample size which leads to a potential for larger standard deviations and more bias than larger randomized studies. However, despite this potential limitation, and the fact that the subjects all resided within the same independent living community and were previously active, the results of this study are consistent with many previous studies that involved larger randomized samples from various communities (Alfieri et al., 2010; Jacobson et al., 2011; Shumway-Cook et al., 2007). Furthermore, there were no significant differences ($p > .05$) in pre-intervention physical functioning (based on pre-assessment testing) between the two groups.

The arm curl test (i.e., a bicep curl) is a common assessment for upper body strength, however, it may be a limitation in the sense that the strength of the bicep muscle is relatively minor in relation to the cumulative strength of the other muscles in the upper body. As such, it would be interesting to develop an upper body strength test with an exercise that incorporates more upper body muscle recruitment such as the Keiser biaxial upper back machine or even the lifting of a bag of groceries.

As for functional balance, the combined assessments of the SFBBS proved to be an extremely relevant measure of functional balance as it included physical tasks that individuals do everyday such as getting out of chair, picking up an item off the floor, and leaning and reaching forward. This test, along with the parent Berg Balance Scale, has consistently been utilized with success and high reliability among a variety of individuals with varying degrees of function and disability (Chou et al., 2006; Jacobson et al, 2011; Kuptniratsaikul et al., 2011,). If this study were to be replicated or expanded upon, the use of the SFBBS would be highly recommended. Additionally, although a larger standard deviation may appear as a limitation, the control group's standard deviation on the SFBBS was much greater than the intervention group ($\pm$ 5.84/5.31 versus $\pm$1.4/1.03, respectively) which was due to not only a smaller sample size but also may have been affected by the subjects' motivation and/or experience.

Given that functional balance is a combination of many systems; motor, somatosensory, vestibular, and vision it is very encouraging that the assessment measuring functional balance (the SFBBS) saw the greatest improvement, as this is the dependent variable most closely related to the ability to perform ADL (Collins et al.; Rose, 2010). The fact that the intervention group in this study produced significant results in the SFBBS bodes well to the adaptability of the intervention because the majority of the subjects had some form of a sensory-related condition (aside from the typical age-related decline), with the most common being visual disturbances. Interestingly, Alfieri et al., (2010) excluded individuals from their study with visual impairments; yet another reason that particular study may have observed greater improvements in functional mobility.

A key component of this intervention, and most likely the strongest aspect of this study, was the use of altered bases of support and the manipulation of the sensory stimuli. The findings of this study parallel the findings of other studies wherein positive results were observed in dynamic and static balance following interventions using balance exercises with compliant surfaces (such as Dyna Discs, stability balls and Airex balance pads) and sensory challenges (Alfieri et al., 2010; DiBrezzo et al., 2005; Jacobson et al., 2011).

As for the other two dependent variables (chair stand and 8-foot-up-and-go), although there was no statistical significance among the intervention group ($p < .158$ & .057, respectively), there was a positive trend and evidence of clinical significance. While as a whole the intervention group failed to meet a certain level of improvement in these dependent variables, individual members were able to reap benefits in the areas of leg strength and walking speed. This was made evident by all of the subjects within the intervention group lifting more weight on the leg press and leg curl machine by the end of the intervention and further supported by one subject eliminating her dependence on her walker. Additionally, the subjects with the slowest pre-assessment 8-foot up-and-go times all experienced remarkable improvements (Table 2). Interestingly, the reverse was true for the control group. That is the control group actually saw a decline in the mean value of each dependent variable from pre- to post intervention (Table 1), which suggests that the intervention may protect against age-related functional decline.

Functional decline, which can be mitigated through regular exercise, is a decreased capacity to perform normal everyday activities independently, safely, and without undue fatigue (Collins et al., 2004; Rikli & Jones, 2002). The decline of the control group's functioning is somewhat consistent with what was observed in Taguchi et al. (2010) and Jacobson et al. (2011). The intervention group in Taguchi et al. did not have any significant changes in walking speed or stride length, but the control group's walking speed and stride length actually declined. In Jacobson et al., the control group saw a decline in all dependent variables (which included the 8-foot up-and-go, Berg Balance Scale and chair stand test) while significant improvements were observed among the intervention group.

Noticeable difference between Taguchi et al. and this study was the pre-intervention functioning of the subjects and the assessment process used to evaluate walking speed and stride length. Taguchi et al. used a 6-minute walk test, which is not a test for walking speed and agility, but rather a test originally developed to assess cardiorespiratory fitness of cardiac patients (Reybrouck, 2003). They also evaluated subjects who all needed some amount of assistance with activities of daily living. In short, the subjects in Taguchi et al. were of lower functioning, but performed a much longer assessment (6 minutes of walking compared to less than 20 seconds in the 8-foot up-and-go) than the current study. Additionally, while the 8-foot up-and-go is specifically an assessment of walking speed and agility, the 6-minute walk test only gives a rough estimate of general physical functioning (Reybrouck). Given this, Jacobson et al. more closely parallels this study and the encouraging aspect of Jacobson is that the intervention (although it lasted 12 weeks) involved the subjects performing balance and leg exercises for only 12 minutes, 3 times a week.

Regardless of the differences of the aforementioned studies, these results reveal how quickly noticeable and appreciable physical changes can occur among older adults, especially among those over the age of 85. The observed aggregate decline of the control group may be related to chronic disease and physical ailments, which often limits an older person's activity level, and then due to the decreased physical activity and self-limiting behavior, they actually became weaker and exacerbate their condition (Collins et al., 2004). Another reason behind the decline could be natural everyday functional variability (Collins et al.). Interestingly, one of the biggest barriers older adults encounter relating to exercise are health concerns and/or pain. Specifically, they are afraid exercise will worsen their physical symptoms when in reality it has the potential to improve their physical well-being.

Many older adults fail to realize that without exercise they risk degenerating into an even lower functioning level (Schutzer & Graves, 2004). This reveals a different goal for exercise among older adults, specifically those individuals classified as "very old" (over 85 years old). While increased fitness is an achievable goal for this age demographic, the most important goal for individuals among the elderly population should be to maintain their present strength and functioning. The results from the control group (which parallel Jacobson et al., 2011 & Taguchi et al., 2010) demonstrate the critical need for exercise in an elderly person's life.

While there was no significance statistically in regards to the 8-foot up-and-go ($p < .057$), components of key functional aspects associated with this assessment were significantly improved, namely upper body strength and static and dynamic balance. Rising from a chair for many older adults takes some amount of upper body strength. Upper body strength combined with lower body strength is a major factor in determining if a person is capable of rising from a chair without assistance.

Meanwhile, balance is needed for walking speed and agility. The 8-foot up-and-go is a task that requires upper body strength, lower body strength and balance (the ability to maintain the body's center of gravity over a base of support whether stationary or moving; Rose, 2010). Additionally, although the results for this dependent variable among the intervention group were not statistically significant, they were extremely close with a p-value of .057.

This leads to the possibility that had the training intervention been slightly longer (i.e., 12 weeks), significant changes may have been observed relating to this particular dependent variable. The 8-week period of the intervention for this study was selected because it is consistent with previous studies (Kammerlind et al., 2001; Rowe & Kahn, 1998), long enough to observe results, yet short enough to limit attrition. In comparison Taguchi et al, (2010), which involved a 12-month intervention, experienced a 19% attrition rate, whereas the current study experienced zero attrition.

In DiBrezzo et al., (2005) significant results were obtained in the chair stand test with a 10-week stretching, strengthening, and balance intervention. This supports the thought that had the intervention in this study been slightly longer, significant results may have been observed in the chair stand test. Additionally, because the chair stand test is the most difficult test for older adults to perform (based on personal observation and data gathered from this study), perhaps executing different strength training exercises that would serve to increase lower body strength specific to this test would have elicited different results. Again, given this small difference in time (8 weeks compared to 10 weeks), this supports what a minor limitation the duration of this intervention posed.

Moreover, since program compliance is an issue for this population, making the program only eight weeks increased the likelihood participants would be in attendance for the majority of the 16 sessions. Furthermore, while the number of participants in this study was small (17 combined among the intervention and control group), it does represent approximately 10% of the population at this particular residential community. By having all the subjects in this study from the same residential community, it eliminates demographic and socioeconomic factors that may affect results had subjects been recruited from various communities and residential settings, and it also increased the likelihood of compliance.

Anecdotal evidence collected throughout the intervention revealed that the intervention not only improved aspects of daily living, such as grocery shopping and dressing one's self, but it also promoted confidence and motivation within the subjects. This again supports the clinical significance of this intervention as real life benefits were gained by the subjects. Many subjects continued to perform the strength training exercises on their own following the intervention and some participated in more activities than they had prior to the intervention. This is extremely encouraging as Rowe & Kahn (1998) examined results from a study involving an 8-week, 3-days-a-week strength training program that had phenomenal functional results that surprisingly were maintained with just one weight training session per week. Functionally speaking, one subject in the intervention group reported being able to carry her groceries with more ease, while another discontinued using her walker halfway through the intervention.

An observable treatment effect in both the 8-foot up-and-go and chair stand was observed despite the lack of statistical significance ($p > .05$). For example, improving walking speed and agility made real life differences among some of the subjects, namely the woman who discontinued use of her walker. These outcomes are similar to what was observed in Westcott & Simons (2006) wherein one woman improved her functional capacity by so much she left the assisted living facility and returned home to live with her husband. Other participants in Westcott and Simmons commented on how the intervention was a positive experience and that they would continue the exercise program on their own.

It has been proposed that the sheer act of performing exercise gives an individual a sense of accomplishment and self-sufficiency that they may not be getting in other areas of their life, and that their mental well-being (received via participation in exercise) positively affects their function and overall health even if only modest or negligible effects are made in regard to physical fitness (Buchner, 2003; Justice, Hamid, Kamalden, & Ahmad, 2010; Kimura, 2010).

Although the subjects met certain physical criteria, such as being able to walk 20 feet unassisted, they each came to the intervention with various physical limitations and chronic diseases. In fact, all ten subjects in the intervention group had high blood pressure (with the majority controlled via medication) and 50% of them had some sort of eye disease or disorder, which included macular degeneration, cataracts, Graves' disease, and a detached retina. Three of the subjects suffered a previous myocardial infarction and five had suffered a prior stroke or transient ischemic attack. Two of the subjects had previous joint replacements (hip and knee). The totality of these disorders illustrate how this program is not limited to only "healthy" populations, and can be tailored to individual needs. Lastly, given that vision is an aspect of balance and the increasing prevalence of eye disorders is associated with increased fall rates, it is extremely encouraging that despite compromised vision, participants were still able to obtain significant improvements in their balance (Rose, 2010).

Future Research

Strength, although a major component of function, is not the only aspect of functional fitness—balance is also essential. Recent studies involving functional fitness and the senior population have involved multiple types of exercise interventions (not just strength or balance training). However, no specific training protocols or guidelines have been established for functional fitness for this population. The results of this study support the need and the importance of developing functional fitness exercise regimens for older adults that include a combination of strength and balance training that can be prescribed and/or encouraged by physicians and administered by fitness professionals in senior living communities. Additionally, this study revealed (as did Rose, 2008 & Shimada et al., 2003) that varying and selective interventions need to be developed based on functional tolerance and fall risk of the participants. Specifically, trained professionals are needed to lead and/or develop these programs that can deliver modified or tiered guidelines based on individual participant functioning.

Another goal for future research would be to not only address the need for selective interventions, but also to incorporate programs that are relatively easy and economical to implement (Kuptniratsaikul et al., 2011; Shimada et al., 2003). The conclusion should be the American College of Sports Medicine (ACSM) incorporating a specific and detailed position statement pertaining to functional training for individuals over the age of 65 that could easily be implemented by a trained professional in a community setting.

Deconditioning is a downward spiral, and as evidenced by the trend seen among the control group, something that can happen rather quickly among our elderly population. Future studies that examine the effects of such a program comparing younger older adults (i.e., ages 65-75) to older groups (i.e., ages 85+) would be met with a lot of interest as that is the age demographic that is currently experiencing the greatest growth. In addition, because the differences in physical ability between males and females in this age demographic are not significant, gender was not used as a covariant in this study, but understanding gender differences as they pertain to younger older adults would be beneficial in terms of program design, especially in the younger elderly subgroups. Additional research could also look into randomized studies, particularly those with longer interventions (12-16 weeks).

Aside from age and gender differences, socioeconomic factors may play a role in physical function in older adults. It has been revealed that individuals with lower levels of education and/or are from a lower socioeconomic status are more inclined to have lower levels of functioning and an increased number of chronic conditions (Collins et al., 2004). Studies have discovered that individuals with higher levels of education appear to have a greater ability to modify their behaviors and manage their chronic conditions through better medical compliance and perhaps more accessibility to health education and programs (Collins et al; Knickman & Snell, 2002).

Although socioeconomic factors have been found to affect compliance within exercise programs, analyzing the impact of funding programs in lower class areas would be worthwhile. Perhaps it is conceivable, with the right type of intervention and the uncertain future of health care, that individuals of lower socioeconomic status would embrace exercise programs and behavior modification with more motivation.

Conclusion

Sadly, 75-85% of older adults do not participate in any form of regular physical activity (Collins et al., 2004; Nied & Franklin, 2002; Rose, 2010). The ability to maintain mobility and the ability to perform normal everyday activities is essential to a higher quality of life (Jones & Rikli, 2002). The outcome and trends in this study, as well as the research referenced throughout this thesis, support the need for exercise programs that are specifically designed for older adults that focus on balance, strength, and functional fitness. Exercise to promote function is the crux of this study. By enhancing an individual's function, be it by making walking a little bit easier or grocery shopping less fatiguing, has the ability to add a tremendous amount of value to an older person's quality of life. With a significant amount of our population over the next 30-40 years moving into "senior" status, this area of research has the potential to assist many people in areas of their life that they currently may take for granted. Additionally, if functional decline can be averted in the earlier years of retirement, perhaps the face and climate of elder care will change.

Finding means through research and development to postpone mobility limitations and maintain functional independence are crucial for our aging population. Ideally, if older adults are able to improve their balance and retain or slow down age-related muscle loss and, ultimately loss of function, then they will be able to achieve a higher quality of life and lessen the financial and care burden that an increasingly older population potentially creates for our society.

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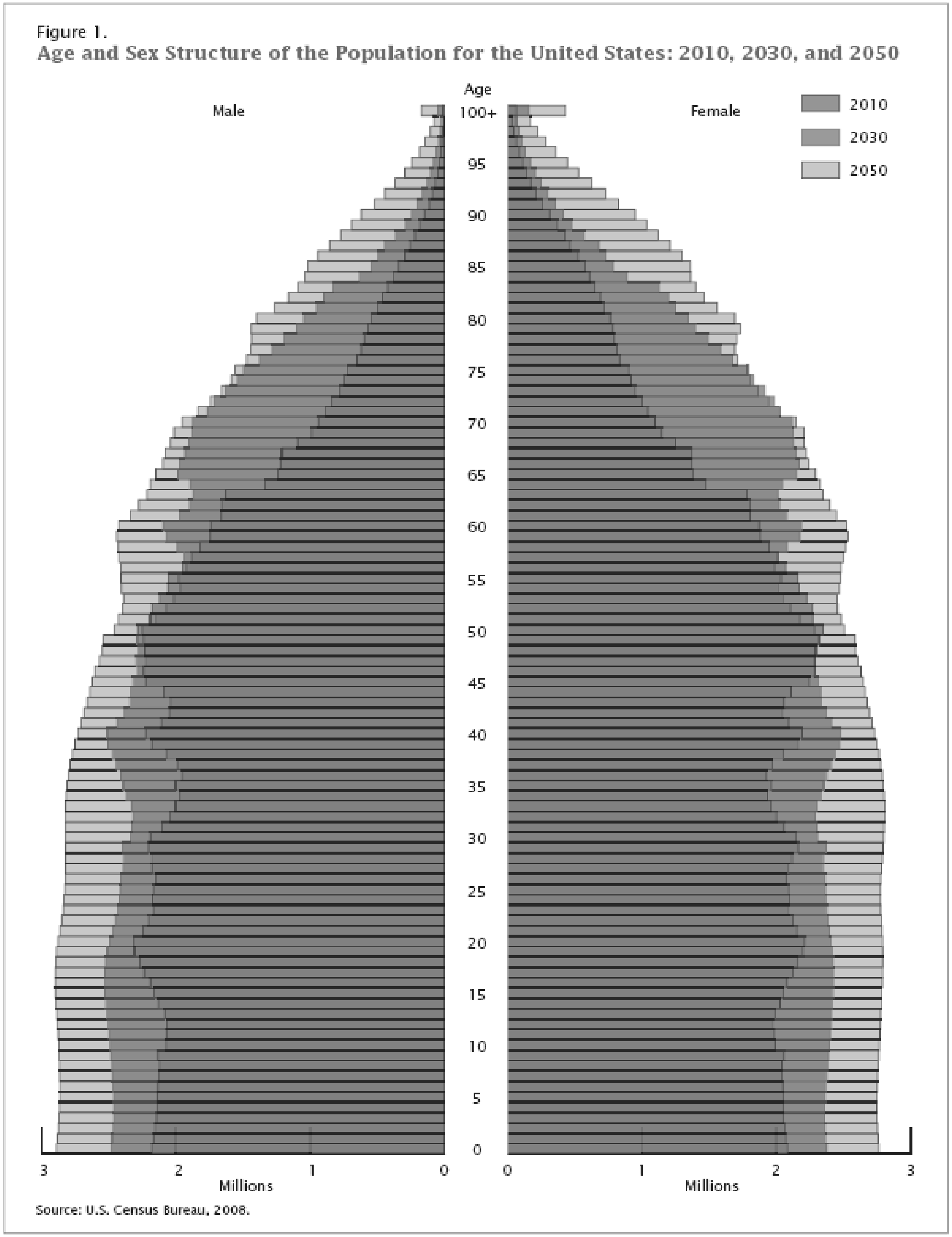
APPENDIX

Appendix A: Age Structure of the Population for the U.S.: 2010, 2030, and

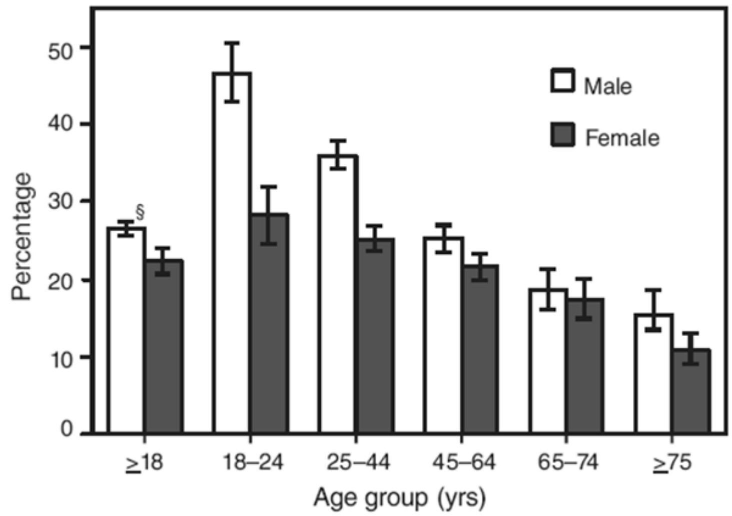


2050[2]

U.S. Census Bureau

Appendix B: 2008 National Health Interview Survey

Percentage of Adults Aged ≥18 Years Who Engaged in Leisure-Time Strengthening Activities,* by Age Group and Sex — National Health Interview Survey, United States, 2008†



*Based on responses to the following question: “How often do you do leisure-time physical activities specifically designed to strengthen your muscles, such as lifting weights or doing calisthenics?”

†Estimates are based on household interviews of a sample of the civilian, noninstitutionalized U.S. population.

§ 95% confidence interval.

Appendix C: Health and Activity Questionnaire

Date:
Name:
Address:
City- State- Zip:
Home Phone : (   )

Gender: Male ❑ Female ❑
Date of birth:
Height: ____ Weight ___
Person to contact in a case of emergency _______ Phone (   )
Name of your physician __________ Phone (   )

1. Have you ever been diagnosed as having any of the following conditions?
If yes, year of diagnoses

Heart attack ❑ Yes ❑ No ___________________________
Transient ischemic attack ❑ Yes ❑ No ___________________________
Angina (chest pain) ❑ Yes ❑ No ___________________________
High blood pressure ❑ Yes ❑ No___________________________
Stroke ❑ Yes ❑ No___________________________
Peripheral vascular disease ❑ Yes ❑ No___________________________
Diabetes ❑ Yes ❑ No___________________________
Neuropathies (problems with sensations) ❑ Yes ❑ No ___________________________
Respiratory disease ❑ Yes ❑ No ___________________________
Parkinson's disease ❑ Yes ❑ No ___________________________
Multiple sclerosis ❑ Yes ❑ No ___________________________
Polio/post-polio syndrome ❑ Yes ❑ No___________________________
Epilepsy/seizures ❑ Yes ❑ No___________________________
Other neurological conditions ❑ Yes ❑ No___________________________
Osteoporosis ❑ Yes ❑ No___________________________
Rheumatoid arthritis ❑ Yes ❑ No___________________________
Other arthritic conditions ❑ Yes ❑ No___________________________
Visual/depth perception problems ❑ Yes ❑ No___________________________
Inner ear problems/recurrent ear infections ❑ Yes ❑ No___________________________
Cerebellar problems (ataxia) ❑ Yes ❑ No___________________________
Other movement disorders ❑ Yes ❑ No___________________________
Chemical dependency (alcohol or drugs) ❑ Yes ❑ No___________________________
Depression ❑ Yes ❑ No___________________________

2. Have you ever been diagnosed as having any of the following conditions?

Cancer ❑ Yes ❑ No
If yes, describe what kind:

Joint replacement ❑ Yes ❑ No
If yes, how many times?
❑ Right hip
❑ Left hip
❑ Right knee
❑ Left knee

Cognitive disorder ❑ Yes ❑ No
If yes, describe condition:

Uncorrected visual problems ❑ Yes ❑ No
If yes, describe type:

Any other type of health problem? ❑ Yes ❑ No
If yes, describe conditions:

3. Do you currently experience any of the following symptoms in your legs or feet?

Numbness ❑ Yes ❑ No
Tingling ❑ Yes ❑ No
Arthritis ❑ Yes ❑ No
Swelling ❑ Yes ❑ No

4. Do you currently have any medical conditions for which you see a physician regularly?
❑ Yes ❑ No
If yes, describe conditions:

5. Do you require eyeglasses? ❑ Yes ❑ No

If yes, what type of glasses do you wear?
❑ Bifocals
❑ Graded lenses
❑ Magnification only
❑ Trifocals

6. Do you have your eyesight checked at least once a year?
❑ Yes ❑ No

7. Do you require hearing aids? ❑ Yes ❑ No

If yes, which ear? ❑ Left ❑ Right ❑ Both

8. Do you use an assistive device for walking? ❑ Yes ❑No ❑ Sometimes

If yes or sometimes, what type of assistive device do you use?
❑ Single-point cane ❑ Rolling stand walker
❑ Three-point cane ❑ Three-wheel walker with seat
❑ Quad cane

9. List all medications that you currently take (including all over-the-counter and alternative medicines)

Type of Medication **For what condition?**

____

____

____

____

____

____

____

____

10. Have you required emergency medical care or hospitalization in the last year?
❑Yes ❑No
If yes, please list when this occurred and briefly explain why.

11. Have you ever had any condition or experienced any injury that has affected your balance or

ability to walk without assistance? ❑ Yes ❑ No
If yes, please list when this occurred and briefly explain condition or injury.

12. How many times have you fallen *within the past 6 months*?

If you have fallen in the past 6 months, please give a detailed description of the incident.
a. Date:
b. Location (i.e., indoors, outdoors):
c. Reason for fall (i.e., uneven surface, going down stairs):
d. Did you require medical treatment? ❑ Yes ❑No
e. Please provide some details for any additional fall you had in the past 6 months:

13. How concerned are you about falling?
❑ 1 ❑2 3❑ ❑ 4 ❑5 ❑ 6 ❑ 7
Not at all A little Moderately Very Extremely

14. As a result of this concern, have you stopped doing some of the things you used to do or liked
to do?
❑ Yes ❑ No

15. How would you describe your overall health?
❑ Excellent ❑ Very good ❑ Good ❑ Fair ❑Poor

16. In general, how would you rate the quality of your life?
❑ 1 ❑ 2 ❑ 3 ❑4 ❑ 5 ❑ 6 ❑ 7
Very low Low Moderate High Very high

17. Please indicate your ability to do each of the following. (Place a √ in the most appropriate box.)

	Can do	**Can do with difficulty or with help**	**Cannot do**
a. Take care of own personal needs (e.g., dressing yourself)	❑ **2**	❑ **1**	❑ **0**
b. Bathe yourself, using tub or shower	❑ **2**	❑ **1**	❑ **0**
c. Climb up and down a flight of stairs (e.g, second story)	❑ **2**	❑ **1**	❑ **0**

d. Do light household activities (e.g., cooking, dusting, washing dishes, sweeping a walkway)	❑**2**	❑**1**	❑**0**
e. Do heavy household activities (e.g., scrubbing floors, vacuuming, raking leaves)	❑**2**	❑**1**	❑**0**
f. Do own shopping for groceries or clothes	❑**2**	❑**1**	❑**0**
g. Walk outside (one or two blocks)	❑**2**	❑**1**	❑**0**
h. Walk 1/2 mile (0.8 km, 6-7 blocks)	❑**2**	❑**1**	❑**0**
i. Walk 1 mile (1.6 km, 12-14 blocks)	❑**2**	❑**1**	❑**0**
j. Lift and carry 10 pounds (4.5 kg, e.g., a full bag of groceries)	❑**2**	❑**1**	❑**0**
k. Lift and carry 25 pounds (11 kg, e.g, medium to large suitcase)	❑**2**	❑**1**	❑**0**
l. Do strenuous activities (e.g., hiking, calisthenics, moving heavy objects, bicycling, aerobic dance activities, strenuous digging in garden)	❑**2**	❑**1**	❑**0**

18. In general, do you currently require household or nursing assistance to carry out daily activities?
❑Yes ❑No

If yes, please check the reasons.
❑Health problems
❑Chronic pain
❑Lack of strength or endurance
❑Lack of flexibility or balance
❑Other reasons:____

____

____

19. In a typical week, how often do you leave your house (to run errands, go to work, go to meetings, classes, church, social functions, etc.)?

❑less than once ❑3-4 times ❑1-2 times ❑almost every day

20. Do you *currently* participate in regular physical exercise (such as walking, sports, exercise classes,
housework, or yard work) that is strenuous enough to cause a noticeable increase in breathing, heart rate, or perspiration?

❑Yes ❑No

If yes, how many days per week?

❑One ❑Two ❑Three ❑Four ❑Five ❑Six ❑Seven

21. When you go for walks (if you do), which of the following best describes your walking pace?

❑Strolling (easy pace, takes 30 minutes or more to walk a mile)
❑Average or normal (can walk a mile in 20-30 minutes)
❑Fairly brisk (fast pace, can walk a mile in 15-20 minutes)
❑Do not go for walks on a regular basis

22. Did you require assistance in completing this form?

❑None (or very little) ❑Needed quite a bit of help

Reason: ____

____

____

Appendix D: Medical Clearance Form

MEDICAL CLEARANCE FORM FOR:

____

Resident's name - please print

Dear Physician,

The Village of Westland is developing a strength and balance training program on campus and your patient has expressed a desire to participate in this program. Participation in this program may reduce your patient's risk of falling and increase their ability to perform activities of daily living.

The class will meet 2 times per week, 1 hour per session for 8 weeks and will incorporate strength exercises utilizing weight machines, dumbbells, and/or calisthenics. The balance training portion of said program will incorporate exercises that are designed to improve center-of-gravity, posture, gait and the multisensory systems involved with balance (visual, vestibular, and somatosensory).

All classes will be supervised and assisted by a National College of Sports Medicine (NASM) trained and certified instructor and will follow the American College of Sports Medicine (ACSM) guidelines as they pertain to exercise for individuals over the age of 65. Individual fitness assessments will be conducted to track outcomes.

<u>Please initial the box</u> that reflects your wishes for the patient named above, write any comments, then <u>sign, date and return this form</u> to the contact person indicated below.

______ *Initials* a) I concur with my patient's participation <u>with no restrictions</u>.

______ *Initials* b) I concur with my patient's participation in this program <u>with the restrictions listed below</u>.

______ *Initials* c) I <u>do not</u> concur with my patient's participation in this program. My justification is indicated below.

Comments:

____

Physician's name - please print *Date*

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Physician's signature

<u>Please return this form at your earliest convenience to</u>:

Appendix E: 8-week Balance & Strength Exercise Table

		Examples	Reps/Sets	Time
Weeks 1-2	**Balance Exercises**			**30 min. (total)**
	●Seated	Warm-up with tall posture, arms at side-strong core. Progress to hands on lap, arms crossed over chest, and then eyes closed.	15 sec. x 4	5-7 min. (total seated)
		Arms straight out at side, then alternate one arm up, one arm down.	Hold 3 sec. (follow w/eyes and head)	
		Weight shifts (forward, right, back, left)	5 rotations	
		March (wide), March (close)	20 sec. x 6	
	●Standing	Hold tall posture	15 sec. x 2	8-10 min. (total standing)
		Stand on one leg	10 sec x 5	
		Tandem stance	15 sec. x 4	
		March w/head turns	20 sec. x 2	
		Walking w/cued starts and stops		
		Walking on tip toes	20 feet x 4	
		Walking on heels	20 feet x 4	
	Strength Exercises			**30 min. (total)**
		Bicep curl	12 x 2 sets	
		Upright Row	12 x 2 sets	
		Leg Press	12 x 2 sets	
		Chest Press	12 x 2 sets	
		Leg Curl	12 x 2 sets	
		Upper Back	12 x 2 sets	

		Wall squats	12 x 2 sets	
		Examples	**Reps/Sets**	**Time**
Weeks 3-4	**Balance Exercises**			**30 min. (total)**
	● Seated	Warm-up with tall posture, hands on lap, arms crossed over chest, and then eyes closed.	15 sec. x 4	5-7 min. (total seated)
		Arms straight out at side, then alternate one arm up, one arm down.	Hold 3 sec. (follow w/eyes and head)	
		Weight shifts (forward, right, back, left)	5 rotations	
		Vision tracking w/pointer and shiny, busy pattern card		
		March (wide), March (close) Marching w/head turns	20 sec. x 6	
		Bean bag toss while sitting on Dyna Disc	20 sec. x 6	
	●Standing	Hold tall posture Stand on one leg Tandem stance March w/head turns	15 sec. x 2 10 sec x 5 15 sec x4 20 sec. x 4	8-10 min. (total standing)
		Walking w/cued starts & stops Walking through cones		
		Walking on tip toes Walking on heels	20 feet x 4 20 feet x 4	
		Balance on Airex pad, walk over 2” compliant pad		
	Strength Exercises			**30 min. (total)**
		Bicep curl	12 x 2 sets	Bicep curl-standing or w/altered based of support
		Upright Row	12 x 2 sets	
		Leg Press	12 x 2 sets	
		Chest Press	12 x 2 sets	
		Leg Curl	12 x 2 sets	
		Upper Back	12 x 2 sets	
		Wall squats	12 x 2 sets	

		Examples	Reps/Sets	Time
Weeks 5-6	**Balance Exercises**			**30 min. (total)**
	●Seated	Warm-up with tall posture, , arms crossed over chest, and then eyes closed.	15 sec. x 4	5-7 min. (total seated)
		Weight shifts (forward, right, back, left)	5 rotations	
		Vision tracking w/pointer and shiny, busy pattern card		
		March (wide), March (close) Marching w/head turns	20 sec. x 6 20 sec. x 6	
		Leg Extensions Knee Lifts	10 x 3 sec. hold 10 x 3 sec. hold	
		Ball toss while sitting on Dyna Disc or stability ball		
	●Standing	Hold tall posture Stand on one leg Tandem stance-w/vision target Foot slides w/towel	15 sec. x 2 10 sec x 5 15 sec x4 15 x 3 directions	8-10 min. (total standing)
		Walking over imaginary wire	20 feet x 2	
		Walking on tip toes Walking on heels	20 feet x 4 20 feet x 4	
		Balance on Airex pad, walk over 2” compliant pad		
	Strength Exercises			**30 min. (total)**
		Bicep curl Upright Row Leg Press Chest Press Leg Curl Upper Back Wall squats	12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets	Bicep curl-standing or w/altered based of support

		Examples	Sets/Reps	**Time**
Weeks 7-8	**Balance Exercises**			**30 min. (total)**
	●Seated	Warm-up with tall posture , arms crossed over chest, and then eyes closed.	15 sec. x 4	5-7 min. (total seated)
		Leg Extensions Knee Lifts	10 x 3 sec. hold 10 x 3 sec .hold	
		Vision tracking w/pointer and shiny, busy pattern card		
		March (wide), March (close) Marching w/head turns	20 sec. x 6 20 sec. x 6	
		Ball toss while sitting on Dyna Disc or stability ball		
	●Standing	Hold tall posture Stand on one leg Tandem stance	15 sec. x 2 10 sec x 5 15 sec x4	8-10 min. (total standing)
		Medicine Ball foot rolls	15 x 3 directions	
		Walking over imaginary wire	20 feet x 2	
		Walking on tip toes Walking on heels	20 feet x 4 20 feet x 4	
		Balance on Airex pad-eyes closed, walk over 2” compliant pad		
	Strength Exercises			**30 min. (total)**
		Bicep curl Upright Row Leg Press Chest Press Leg Curl Upper Back Wall squats	12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets 12 x 2 sets	Bicep curl-standing or w/altered based of support